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HARVEST DYNAMICS AND WINTER HABITAT

USE OF THE PINE MARTEN

IN SOUTHWEST MONTANA

by

Craig William Fager

A thesis submitted in partial fulfillment
of the requirements for the degree

of

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in

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APPROVAL

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## ABSTRACT

A 1-year study of pine marten habitat use and harvest dynamics was conducted in 3 study areas in southwest Montana. The primary objective of the study was to obtain baseline information about a species thought to be an old growth forest inhabitant and highly susceptible to fur trapping. Marten were live-trapped and fitted with radiocollars in the fall of 1989. Trapper catches were monitored to evaluate the effects of trapping on marten populations. Additional marten were trapped during the winter months. Marten were located through radio telemetry and snow tracking to determine habitat preferences and the effects of habitat alteration on local marten populations. Relative density was established through track transects during the winter months. Habitat variables were measured at marten locations and comparable random sites during the summer, 1990. Trappers harvested 27% (Beaver Creek) to 100% (West Yellowstone Flats) of marked marten during a trapping season regarded as poor by trappers. Fur trapping effort varied between study areas but was highest in the Big Hole study area where harvest was greatest. Marten densities were highest in the Big Hole study area, intermediate in the Beaver Creek study area, and lowest in the Flats study area. Trapping had little impact on marten populations in 3 study areas in southwest Montana during 1989-1990. Marten populations were probably at low levels prior to the trapping season and marten remained in each study area after the trapping season. Large untrapped reservoirs adjacent to trapped areas may have provided surplus marten to restock trapped areas. Marten were located in every forested habitat in each study area. Habitat preference was for mesic lodgepole pine habitats in the West Yellowstone Flats area and mesic subalpine fir and Douglas-fir habitats in the Big Hole area. Marten rested primarily in subnivean sites created by woody debris. Physical measurements of habitat indicated the marten used a variety of sites with different structural attributes. The marten may be more flexible in habitat use than characterized in the literature.

# INTRODUCTION

In recent years, the pine marten (<u>Martes</u> <u>americana</u>) has moved from relative obscurity to a place of high visibility in the minds of resource managers. This is largely because the marten is perceived as a habitat specialist evolved to live in old growth forests, a community designation that evokes strong feelings from economic and environmental interests (Koehler et. al 1975, Franklin et. al 1981). This perception has prompted a majority of National Forests in the Northern Region to name the marten as an old-growth management indicator species (Code of Federal Regulations 219.19). Unfortunately, there are only limited basic biological data to justify this designation.

Buskirk (1983) stated that "the belief that Alaskan marten thrive on unbroken, pure stands of conifer forest belies our ignorance of the life requisites of this species." This statement may also be valid for marten in southwest Montana. No one knows how the marten fits into habitats in southwest Montana because no information on marten habitat use has been collected.

Marten habitat use has been extensively investigated over most parts of its range (Steventon 1979, Buskirk 1983, Raine 1983, Hargis and McCullough 1984). However, a gap is

present in drier portions of the Rocky Mountains, including southwest Montana, where marten occur. With timber harvesting pressure mounting on the remaining old-growth forests in this region, the need to determine how the marten uses habitat in southwest Montana has never been greater.

For decades, the only information collected on marten in southwest Montana has been pelt-tagging data from trappers (Frisina, Pers. Comm.). These data are useful for establishing general population trends; however, they are subject to fluctuations induced by fur prices, trapper effort, and weather conditions that may be independent of population levels and habitat changes. Concern over the possible consequences of high harvest levels and the impacts of harvest on populations in areas with extensive habitat alteration due to logging has led to the need for a more accurate evaluation of trapping effects on marten populations.

The objectives of this study were to provide baseline information regarding marten habitat use, the effects of alteration of these habitats on population viability, and the effects of marten harvest on population structure in 3 sites in southwest Montana. Field work was initiated in September of 1989 and was completed in September of 1990.

## Study Areas

Three study areas in southwest Montana were selected.

Representative habitat types, land use pressures, and trapper activity were all given consideration in area selection.

Upper Big Hole

The upper Big Hole study area comprised 153 $km^2$ of the Anaconda range in the Beaverhead National Forest (Fig. 1). The area included the Tie, Johnson, Shultz, and Bender Creek drainages. Approximate boundaries were defined by Highway 43 to the South, the Continental Divide to the North and West, and the sagebrush-grassland of the upper Big Hole to the East (Fig. 1)

Elevation varied between 1950 and 2500 m. Annual average precipitation at the town of Wisdom, 15 kilometers to the east, is 30 cm. Average temperature at Wisdom for the month of January is -10.3 °C and for July is 14.4 °C.

Spruce (*Picea spp.*) and subalpine fir (*Abies lasiocarpa*) habitat types dominated drainage bottoms and higher elevation sites in the study area. Lodgepole pine (*Pinus contorta*) and Douglas-fir (*Psuedotsuga menziesii*) habitat types were dominant in drier and lower elevation sites.

Logging, livestock grazing, and recreation were the primary land uses within the study area. Clear-cut logging and associated road building have been extensive in the last 2 decades, and, consequently, motorized vehicle access to a majority of the study area was good.

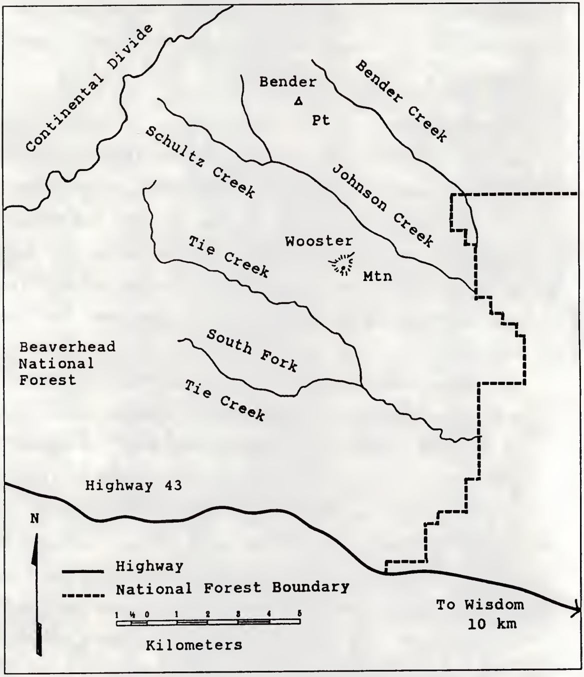


Figure 1. Boundaries and drainage patterns in the Big Hole study area.

<u>West Yellowstone Flats</u>

The 64-$km^2$ Flats-Horse Butte study area (Fig. 2) was located immediately North of the town of West Yellowstone,

on Gallatin National Forest and Yellowstone National Park land. The area was characterized by a mosaic of grassland and forest and was dominated by a lodgepole pine-bitterbrush (Pinus contorta-Purshia tridentata) habitat type that is unique to the West Yellowstone area. Approximate boundaries were Hebgen Lake in the West, Yellowstone National Park in the East, and Cougar Creek in the North.

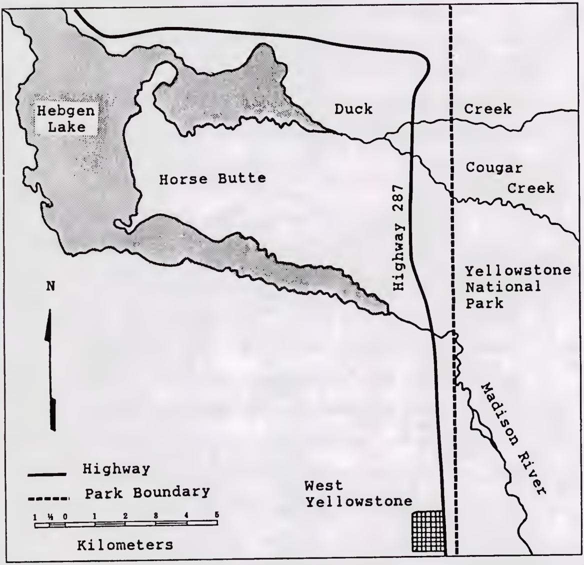


Figure 2. Boundaries and drainage patterns in the West Yellowstone Flats study area.

Most of the study area was located on a high elevation basin (2000m). Horse Butte, on the western edge of the study, with an elevation of 2088 m formed the one exception. Average temperature for the month of January at West Yellowstone is -11.3 °C and for July is 15.6 °C. Precipitation in this area occurs primarily as snow and averages 56.7 cm.

Recreation, logging, and firewood cutting were the primary land uses. One livestock grazing permit was maintained on Horse Butte. The flat open nature of the area allowed almost unlimited motorized access in the lodgepole habitats outside Yellowstone National Park.

Beaver Creek.

The Beaver Creek study area (Fig. 3) was in the Madison Range, between Quake and Hebgen Lakes. Part of the 32-$km^2$ study area was within the Taylor-Hilgard Wilderness Area of the Gallatin National Forest. Steep topography limited most research activities to within 1 km of the road. U.S. Forest Service trails allowed some access into the Cabin-Beaver Creek Divide and the Sentinel Creek drainages.

Study area elevation varied between 1980 and 2500 m. Precipitation and temperature data were unavailable; however, snow depth was generally deeper and persisted longer in the spring than at West Yellowstone.

The primary land use practiced within the study area was recreation. A limited amount of clear-cut logging has

taken place on the study area. U.S. Forest Service trails provide the primary means of access to much of the area. Motorized vehicle access was limited to less than 10 km of summer-passable, unpaved roads.

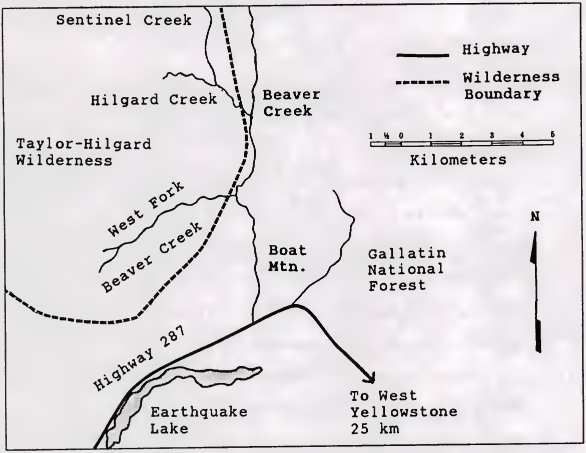


Figure 3. Boundaries and drainage patterns in the Beaver Creek study area.

# METHODS

## Field Procedures

### Live Trapping

Marten were initially live-trapped in October and November 1989 with single door, wire-mesh traps placed in favorable habitats. In order to evaluate the effects of trapper harvest on marten populations, I tried to place traplines in areas regularly used by trappers. Traps were baited with a variety of natural baits and commercial or homemade lures. Traps were checked daily. All sets were covered with evergreen boughs, bark, or placed in natural cavities to protect captured animals from the elements.

Trapping after November was conducted intermittently in the Big Hole and Beaver Creek study areas. The West Yellowstone Flats area was trapped continuously during the winter months except for periods when trappers were actively working their lines. Live-trapping effort was recorded by study area and season in trap-nights (1 trap set for 24 hours).

The first 2 animals captured were handled without the aid of immobilizing drugs. Thereafter, all captured marten were immobilized with 0.12-0.40 cc of ketamine hydrochloride (100 mg/ml). All adult marten and most juvenile marten were

fitted with 148 MHZ radiotransmitters (AVM type P2-B). Most marten were ear-tagged. Sex was noted, and individuals were assigned to juvenile or adult age categories based on sagittal crest examination (Marshall 1951) and wear on canines. Body weights were obtained for a few marten in the upper Big Hole area.

Fur Trapping.

Fur trapping effort in each study area was quantified as trap-nights, number of days spent trapping, and total number of traps employed. In addition, fur trappers were asked to provide specific information about the location and approximate date of capture of any marked animals that were harvested. Overall harvest and sex ratio figures were also obtained from trappers. Differences in techniques between those of fur trappers and my live-trapping were noted.

Marten Locations

Marten were located in each study area through the use of radio telemetry and snow tracking. Telemetry locations were obtained through aerial searching with a fixed wing aircraft, ground triangulation, or pinpointing the signal origin through ground searching. Snow tracking locations were obtained while conducting other project activities. Tracks encountered while travelling on roads or trails were followed a randomly selected number of paces and marked.

Radio telemetry locations obtained from ground searches

were separated into resting or foraging categories based on the directional stability of the radio signal, animal observation, and physical evidence at the location. Snow tracking locations were all classified as foraging. Ground search and snow tracking locations were marked with flagging so they could be accurately identified for additional measurements during summer. All locations were recorded using Universal Transverse Mercator (UTM) coordinates on 1:24,000 U.S. Geological Survey maps.

Track Transects

To establish relative population density by study area, 13 1-kilometer (km) track transects were established and monitored by methods described by Thompson et. al (1989). Transects were run 12 to 72 hours after a snowfall that was likely to have obliterated existing tracks. Results were standardized by the number of activity periods (12 hours) that had passed since the last track obliterating snowfall.

Habitat Analysis

Detailed analysis of vegetation and terrain features at flagged radio telemetry and snow tracking locations was conducted during the summer months of 1990. For comparative purposes, a randomly located set of points was analyzed in an identical manner in the Big Hole and West Yellowstone Flats study area. Modified U.S. Forest Service stand examination procedures (U.S.D.A. 1985) were used to quantify

habitat variables.

Habitat Type Determination. Forested habitat types were delineated according to the Pfister et. al (1977) classification. Non-forested habitat types were delineated according to the Mueggler and Stewart (1980) classification. These systems worked well except for one forested habitat type in the West Yellowstone Flats study area which failed to meet the criteria for any Pfister habitat type. I grouped this habitat with the existing lodgepole pine (Pinus contorta) habitat series and designated it habitat type 960, a designation that was strictly my own.

Clear-cut Evaluation. Habitat types were determined for random points that fell within clear-cuts. However, because clear-cuts lacked the overstory features that forested environments in mature and climax condition assigned to the same habitat types possessed, these points were examined separately. Random points falling in clear-cuts were pooled across all habitat types and examined for ground structural features (logging slash, woody debris) not directly dependent on a mature or climax canopy.

Overstory and Canopy Evaluation. Data related to overstory and canopy features at marten and random locations were collected using a variable plot technique (a plot in which radius increases with increasing diameter of trees. See U.S.F.S manual FSH 2409). A 20 basal area factor (BAF)

prism or angle gauge was used to determine specific trees included in the variable plot. Plot center for marten locations was the point where the marten was located unless the animal was up a tree or snag in which case the point on the ground directly underneath the location was used. Plot center for random points was determined by pacing an estimated distance along a compass bearing from a known map location to the point as indicated on a map.

Height, diameter at breast height (dbh), and species were recorded for each tree $\geq$ 12.7 centimeters (cm) dbh detected in the variable plot. Each tree was classified according to crown class, crown ratio, and merchantability. Canopy cover was determined by ocular estimation from plot center.

Age was determined by boring and counting growth rings for the largest and smallest living trees $\geq$ 12.7 cm dbh in the plot. Standing dead trees (snags) $\geq$ 12.7 cm dbh were tallied in a 0.04-hectare (ha) (11.4-meter (m) radius) fixed plot.

Understory and Ground Cover Evaluation. Trees less than 12.7 cm dbh were evaluated in a 0.001-ha (2-m radius) fixed plot. All trees within the plot were tallied. Small trees of the same species, size, and condition were tallied in groups. Live crown ratio was estimated for trees that were intermediate or co-dominant in crown class.

Ground cover was estimated to the nearest 5% through

ocular estimation in a 0.004-ha (3.5-m radius) fixed plot. In order to maintain consistency with established Forest Service procedures, pinegrass (*Calamagrostis rubescens*) and beargrass (*Xerophyllum tenax*) were the only 2 grass or grasslike plants identified to species. All other grasses, forbs, and sedges were placed in general categories. Shrubs were identified to species and average height was estimated. Bare soil and duff cover were estimated. Ground cover composed of logging slash and natural debris were estimated separately. Average height and percent ground coverage was estimated for each category.

Ground Fuel and Logging Slash Estimation. Ground fuel and logging slash were estimated with methods described by Brown (1974). One 8.2-m transect was run on an easterly bearing from plot center at all radio, snow tracking, and random locations. Intercepts of woody material $\geq$ 7.6 cm in diameter were recorded to the nearest 2.5 cm diameter at the point of intercept and classified as either sound or rotten.

## Statistical Analysis

### Live-trapping and Harvest

Success rates by season from live-trapping during the study and fur trapping by trappers were compared using chi-square statistics. Total trap nights and total captures were the analyzed variables. Capture rates by sex were compared between study areas by using the 2 variables: 1)

total trap nights and 2) captures by sex. The probability of a Type I error was controlled for this and all other statistical tests, except habitat selection, at the 5% level.

Regional Harvest and Pelt Price.

In order to determine the effects of the current marten trapping season structure on marten harvest levels, Montana Department of Fish, Wildlife, and Parks (MDFWP) pelt tagging and pelt price records from 1979 to 1990 were analyzed. Price data were analyzed as dollar values and as values adjusted for inflation to 1979 levels based on the Consumer Price Index (U.S. Department of Labor, 1979-90) for the period 1979-1990.

Univariate t-tests (Snedecor and Cochran 1980) were used to compare 1989-1990 harvest and price figures to 10-year averages. Regression analysis was used to determine if correlations existed between harvest level and marten pelt price. Because the marten season length was reduced from 4 to 2 months in 1987-1988, the variable harvest/month was analyzed to determine possible season length influences on marten harvest.

Home Range

Harmonic home ranges (Dixon and Chapman 1980) were calculated with the program HOME RANGE (Ackerman et. al 1989). Core areas were identified for all animals with

sufficient locations (n>9). One animal with sufficient locations from the winter and spring was evaluated on a seasonal basis.

## Habitat Selection

Habitat selection in the Big Hole and West Yellowstone Flats study areas was determined through use-availability analysis with methods described by Marcum and Loftsgaarden (1980). Small sample sizes in some habitat types necessitated pooling similar habitat types to form habitat type groups. With the exception of meadow and forested scree types, which were combined, groups consisted of types classified within the same habitat series (Pfister et. al 1977). Habitat types in the subalpine fir series in the Big Hole study area were grouped as mesic and xeric series, based on soil moisture rating (Warren 1989).

Tests of habitat selection in the Big Hole and Flats areas were based on all radio telemetry locations, all track locations, and radio telemetry and track locations combined. Radio telemetry locations were then segregated into resting and foraging and compared. Use greater than expected (Bonferoni confidence interval=90%) was noted as evidence of "preference" and use less than expected as evidence of "avoidance". Frequency of use of clear-cuts by marten was compared to the frequency of occurrence of points in clear-cuts in a random sample of points using chi-square statistics.

Physical Habitat Features

Analysis of habitat features at marten and random locations was conducted so that results would be compatible with existing U.S. Forest terminology and databases. Summary statistics from variable and fixed-plot measurements were calculated for marten locations (track sets and radio locations) and random locations using stand analysis programs developed by the U.S. Forest Service (AOS/VS Revision 7.65). Mean basal area/ha, mean trees/ha, and mean volume/ha estimates were determined for each group of locations. Percent ground cover was calculated by cover type or cover type group.

Radio locations were grouped as: 1) individual animals, 2) all location sites (each site recorded only once regardless of the number of times the site was used), 3) and all animal locations (all locations at same site included as independent locations). Random points falling within clear-cuts were treated as an independent set because of their potential to bias values recorded for forested random points.

Habitat measurements that varied from standard U.S. Forest Service procedures were analyzed independently. I organized random and marten locations (track, resting, and foraging locations) by the same habitat series used for analysis of habitat selection. This was done in order to: 1) obtain values for specific variables that could not be

calculated with U.S. Forest Service software, 2) calculate habitat variables for habitat type groups with similar site potential, and 3) minimize bias by making comparisons only between habitats of similar site potential.

Values calculated by habitat series included: mean metric tons/ha of logging slash and/or woody debris (Brown 1974), mean canopy cover, mean snags/ha, and mean stand density index (an association index between average tree diameter and the number of trees/ha) (McTague and Patton 1989). In addition, I calculated mean trees/ha and mean basal area/ha by habitat series.

Physical variables from marten locations were compared with random variables using t-tests for both summary statistics produced through U.S. Forest Service programs and variables produced by habitat series. Measurements assigned to categories (logging slash or woody debris, ground cover) with U.S. Forest Service procedures were compared with chi-square statistics. The hypothesis tested was: no difference between marten locations and random locations.

# RESULTS

## Analysis of Trapping

### Live Trapping

Thirty-seven separate marten were captured at least once during the study (Table 1). Live-trapping success in fall was not significantly different than winter in the Big Hole ($\chi^2$=0.01, df=1, P=0.92) and Beaver Creek ($\chi^2$=0.03, df=1, P=0.86) study areas. Inadequate fall sample size precluded comparisons in the West Yellowstone Flats.

Table 1. Trap nights for fall and winter live-trapping, captures, and trap nights per capture for the Big Hole and West Yellowstone study areas, 1989-1990.

| Study area | Season | Date | Trap nights | Captures | Trap nights/ catch |
|---|---|---|---|---|---|
| Big Hole | Fall | 10/22-11/11 | 878 | 12 | 73 |
| Beaver Creek | Fall | 11/13-11/30 | 523 | 11 | 48 |
| Flats | Fall | 11/13-11/30 | 75 | 1 | 75 |
| Big Hole | Winter | 1/11-3/28 | 610 | 7 | 87 |
| Beaver Creek | Winter | 3/15-4/15 | 120 | 1 | 120 |
| Flats | Winter | 1/6-3/21 | 2708 | 5 | 542 |

Sex ratios of live-trapped marten (Table 2) were compared between study areas where sample size permitted. Winter trapping in the Flats area produced fewer females than fall live-trapping in the Big Hole ($\chi^2$=8.4, df=1, P=0.004) and Beaver Creek ($\chi^2$=20.4, df=1, P<0.001) study areas. The female captured during winter trapping in the Flats represented the only female caught in this study area during the entire field year. The sex ratio for the Big Hole study area prior to the fur trapping season was 1 male (M) to 1 female (F). This decreased to 1.0M:1.33F after the fur trapping season. A sex ratio of 1M:2.33F was observed for Beaver Creek prior to fur trapping.

Table 2. Sex ratio and relative age structure of captured marten by study area and season, 1989-1990.

| Study Area | Season | Sex ratio[a] | Age structure[b] |
|---|---|---|---|
| Big Hole | Fall | 6M:6F | 5MA:1MJ:5FJ:1FA |
| Beaver Creek | Fall | 4M:7F | 3MA:1MJ:3FJ:4FA |
| Flats | Fall | 1M | 1MA |
| Big Hole | Winter | 3M:4F | 1MA:2MJ:2FJ:2FA |
| Beaver Creek | Winter | 1M | 1MA |
| Flats | Winter | 4M:1F | 4MA:1FJ |

[a]M=male, F=Female

[b]MA=adult male, FA=female adult, MJ=juvenile male, FJ=juvenile female

Southwest Montana Marten Harvest

Trappers harvested 271 marten during the 1989-1990 trapping season (December through January) in southwest

Montana (Figure 4). This harvest level was significantly lower than the 444 average from the preceding 10-year period (Univariate t=2.5, df=9, pooled 1-sample variance, P=0.03); however, the 1989-1990 harvest did not represent the lowest for the period as fewer marten were harvested during the 1981-1982 and 1982-1983 seasons.

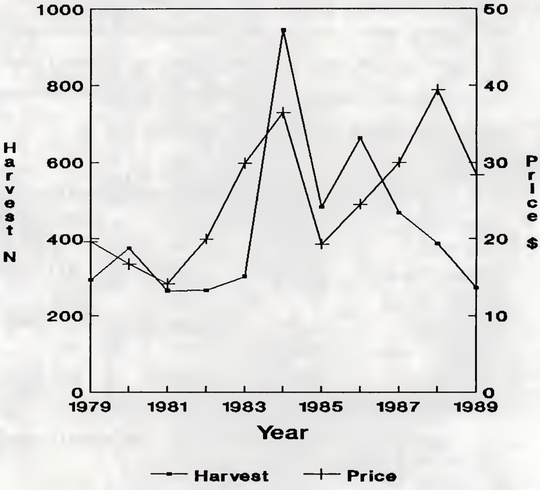


Figure 4. Southwest Montana (State administrative Region 3) marten harvest and average statewide marten pelt price, 1979-1989.

Marten Pelt Prices

The average price for marten pelts sold during the 1989-1990 season was \$28.38 (Hash, Pers. Comm.). This value did not differ from the \$24.97 average from the preceding 10 years (Univariate t=1.2, df=9, pooled 1-sample variance, P=0.24). However, average pelt prices from the same 10-year period adjusted downward for inflation to 1979 values (\$16.23; see Appendix Table 31), were greater than the 1989-1990 adjusted price of \$12.63 (Univariate t=2.8, df=9, pooled 1-sample variance, P=0.019).

Regression analysis of price and harvest level for the period 1979-1989 yielded non-significant correlations for inflation adjusted prices ($R^2$=0.17, P=0.21) and for unadjusted prices ($R^2$=0.19, P=0.17). However, a subset of unadjusted price and harvest data, from 1979 to 1986, yielded a positive significant correlation ($R^2$=0.40, P=0.04). This subset represents that portion of the data collected during years with November through February trapping seasons. In 1987, the trapping season length was reduced to 2 months.

A significant positive correlation was produced with unadjusted price and harvest per month of season data for the 1979-1989 period ($R^2$=0.57, P=0.007). Inflation adjusted prices produced non-significant correlations ($R^2$=0.19, P=0.18) for the same 11-year period.

Study Area Harvest

Trapper harvest varied considerably among study areas. The Big Hole produced the highest harvest level (n=16) while the Lodgepole Flats produced the lowest (n=1). The 1989-1990 harvest in these areas, as well as Beaver Creek (n=6), represented a 70% to 90% reduction from the 1988-1989 season (Depas and Whitman, Pers. Comm.) and from historic harvest levels indicated by pelt tagging records (Table 3).

Table 3. Harvest statistics by study area for the 1989-1990 trapping season.

| Study area | Harvest | Sex ratio | Marked marten | Historic harvest |
|---|---|---|---|---|
| Beaver Creek | 6 | 3M:3F | 3 | 17-20 |
| West Yellowstone Flats | 1 | 1M | 1 | 20[a] |
| Big Hole | 16 | 11M:5F | 2 | 30-50 |

[a]The West Yellowstone Flats area was historically trapped by 2-4 trappers with approximate potential of 7 to 10 marten per trapper

Radio-collared or eartagged marten represented 100% of the known West Yellowstone Flats harvest, 50% of Beaver Creek harvest, and 12.5% of the Big Hole harvest. Vulnerability varied between study areas, with 2 of 5 (40%) marten exposed to trap lines being captured in the Big Hole and 3 of 11 (27%) marten exposed to trap lines being captured in Beaver Creek. The adult male captured in the Flats represented the only known harvest in the area. One radio-collared female in Beaver Creek was killed, apparently

by another marten, early in the fur trapping season. High transmitter failure rates and shedding of transmitters by female marten complicated these analyses.

Sex ratio in the harvest varied from 2.2M:1.0F in the Big Hole to 1M:1F in Beaver Creek. These values were not significantly different from fall sex ratios in live-trapped animals (Big Hole $\chi^2$=0.05, df=1, P=0.82; Beaver Creek $\chi^2$=0.2, df=1, P=0.63). Success rates for individuals trapping for fur (Table 4) were lower than my fall live-trapping success rates in the Big Hole ($\chi^2$=4.5, df=1, P=0.03) and Beaver Creek study areas ($\chi^2$=16.2, df=1, P=0.001). Fur-trapper success rates were not statistically different from winter live-trapping success in the West Yellowstone Flats ($\chi^2$=1.9, df=1, P=0.16).

Table 4. Summary of harvest effort, trap nights, and success rate by study area for the 1989-1990 fur trapping season.

| Study area | Date | Trap nights | No. trappers | Trap nights/ catch |
|---|---|---|---|---|
| Big Hole | 12/1-1/30 | 3000 | 1 | 188 |
| Beaver Creek | 12/1-1/15 | 2100 | 1 | 350 |
| Lodgepole Flats | 12/1-1/1 | 850 | 3 | 850 |

The mean number of days marked marten that were harvested avoided traplines during the trapping season was 24 days in the Big Hole, 17 days in Beaver Creek, and 30 days in the Flats. Linear distance moved from live-capture

to harvest was approximately 5 km for both animals in the Big Hole, and less than 1 km for all animals in the Flats and Beaver Creek. One marked marten was harvested in a trap set for wolverine (Gulo gulo).

Intensity of fur trapping effort, based on the number of days each area was trapped and estimated total trap nights, was greatest in the Big Hole and least in the Flats. Conversely, the Flats area was trapped by 3 trappers while Beaver Creek and the Big Hole study areas were trapped by only 1 trapper in each area. Harvest methods varied among study areas. In the Big Hole study area, traps were placed near marten sign (tracks) and at likely crossing points with 50 to 60 traps spread over a distance of approximately 60 km. The Beaver Creek and Flats study areas were trapped with more permanent trap "houses" that were utilized year after year by the same trapper. Trap density, but not trap numbers, was much higher than in the Big Hole with approximately 9 traps/km in Beaver Creek and up to 7 traps/km in parts of the Flats area.

## Relative Population Density

### Big Hole

Track counts on 5 transects in the Big Hole study area were replicated 5-7 times per transect for a total of 31 km (Table 5). All transects except Transect 1 were within the area worked by the fur trapper. Transects were run between

12 and 48 hours (mean=27.1 hr) after the last track-obliterating snowfall. Overall track density for all transects combined was 0.56 tracks/km.

Table 5. Results from 5 winter track transects in the Big Hole study area. Track densities were standardized by dividing values by the number of 12-hour activity periods since the last track-obliterating snowfall.

| Transect | Major habitat series | Replicates | Density (tracks/km) |
|---|---|---|---|
| 1 | Lodgepole pine | 5 | 0.25 |
| 2 | Mesic subalpine fir | 7 | 0.21 |
| 3 | Xeric subalpine fir | 7 | 0.57 |
| 4 | Xeric subalpine fir | 7 | 0.71 |
| 5 | Lodgepole pine-mesic subalpine fir | 5 | 1.10 |
| Overall means | | 6 | 0.56 |

The highest relative density occurred on Transect 5, the first kilometer of the Bender Creek trail. This transect occurred along an ecotone between mesic subalpine fir stands in the drainage bottom and lodgepole pine dominated stands in the adjacent uplands. The lowest track density was on Transect 2, located at the head end of Johnson Creek in mesic subalpine fir habitat.

Beaver Creek

Four track transects were replicated 4-5 times in the Beaver Creek study area for a total of 18 km (Table 6).

Transects 1 and 2 had the lowest relative densities and were in the harvested portion of the drainage. Transect 3 had the highest relative density. It was trapped in 1988-1989 but not during the 1989-1990 season. Transect 4 had no recent trapping history. Transects were run between 12 and 72 hours (mean=49.3 hr) since the last track-obliterating snowfall. Overall density was 0.41 tracks/km.

Table 6. Results from 4 winter track transects in the Beaver Creek study area. Track densities were standardized by dividing values by the number of 12-hour activity periods since the last track-obliterating snowfall.

| Transect | Major habitat series | Replicates | Density (tracks/km) |
|---|---|---|---|
| 1 | Douglas-fir | 5 | 0.16 |
| 2 | Subalpine fir | 5 | 0.20 |
| 3 | Subalpine fir | 4 | 0.98 |
| 4 | Subalpine fir | 4 | 0.40 |
| Overall means | | 4.5 | 0.41 |

West Yellowstone Flats

Six kilometers of transect measurements were conducted on 4 transects in the West Yellowstone Flats. Only 1 transect produced tracks. This transect had a mean density of 0.55 tracks/km in 3 replicates and a mean sample interval of 28 hours after track-obliterating snowfall. All other transects were only run once during the winter because of interference from almost daily snowstorms and emphasis on other study aspects in this study area. The overall density for the Flats was 0.28 tracks/km.

Home Range

The 95% harmonic home ranges (Dixon and Chapman 1980) for marten (Table 7) varied between 4.9 and 68.0 $km^2$ for all marten. In general, females occupied smaller home ranges than males; however, differences in location numbers precluded statistical comparisons.

Table 7. Ninety-five percent, 75%, and core areas[a] for 9 marten home ranges, by sex and season, from the upper Big Hole, Beaver Creek, and Flats study areas.

| Marten | Sex | Season | Locations | Home range-($km^2$) | | |
|---|---|---|---|---|---|---|
| | | | | 95% | 75% | Core |
| Beaver Creek | | | | | | |
| 727 | F | Winter | 8 | 4.9 | 3.4 | |
| West Yellowstone Flats | | | | | | |
| 205 | M | Winter-Spring | 15 | 68.0 | 28.4 | 13.2 |
| 521 | M | Winter | 28 | 25.7 | 9.0 | 5.6 |
| 845 | M | Winter | 24 | 29.2 | 17.7 | 8.6 |
| 845 | M | Spring | 31 | 56.6 | 24.7 | 17.7 |
| 845 | M | Winter-Spring | 55 | 67.0 | 31.4 | 18.3 |
| Big Hole | | | | | | |
| 970 | F | Winter | 29 | 7.2 | 3.0 | 1.8 |
| 762 | M | Winter-Spring | 10 | 19.1 | 12.8 | 3.8 |
| 492 | M | Winter | 18 | 9.7 | 5.5 | 3.5 |

[a]Core areas reflect approximately 50% of all locations.

Core areas, representing approximately 50% of individual locations, ranged between 1.8 and 18.3 $km^2$. Core

areas in the Flats averaged 12.7 $km^2$ and were between 19 and 31% of the size of 95% harmonic home range areas. Core areas in the Big Hole study area were 1.8 $km^2$ for 1 female and 3.5 and 3.8 $km^2$ for 2 males. These values represented between 19 and 36% of the size of 95% harmonic home range area in the Big Hole.

Home range overlap between adjacent radiocollared marten of the same sex was minimal. Where overlap did occur, marten were never found within the area of overlap at the same time. Male martens 845 and 205 exhibited the highest degree of overlap with approximately 20% of their home ranges being shared. Use within the shared area was irregular and usually of short duration; however, both marten crossed a heavily travelled, improved highway (U.S. 287) to invade each other's home range.

## Habitat Selection

### Big Hole

Marten were located in all habitat series (Appendix Table 32) and all habitats except the meadow type. Habitat use determined from pooled radio and track locations (Table 8) did not conform to the same distribution as in a similar sized set of random points ($\chi^2$=111.5, df=4, P<0.001). Marten exhibited preference, based on 90% Bonferoni confidence intervals, for the mesic subalpine fir series for all location categories and for the Douglas-fir series within

the radio location category. The xeric subalpine fir series was used at less than expected proportions for all marten location categories. All other series were used in proportions similar to those of the random set.

Table 8. Habitat series and habitat type distribution for random (n=116) and marten locations (tracks n=70, radio n=48, combined n=118) for the Big Hole study area. (+) indicates preference and (-) indicates avoidance of the habitat type series as determined by 90% Bonferoni confidence intervals.

| Habitat series | Habitat types[a] | Percent random | Percent tracks | Percent radio | Track-radio combined |
|---|---|---|---|---|---|
| Douglas-fir | 320-330 | 12.9 | 15.7 | +31.2 | 22.0 |
| Lodgepole pine | 940 | 6.9 | 7.1 | 4.2 | 5.9 |
| | 950 | 2.6 | 4.3 | 4.2 | 4.2 |
| Mesic sub-alpine fir | 630 | | +1.4 | +0.0 | +1.0 |
| | 650 | 3.5 | 28.6 | 4.2 | 17.8 |
| | 670 | 7.8 | 5.7 | 27.1 | 15.3 |
| Xeric sub-alpine Fir | 690 | 32.8 | -11.4 | -4.2 | -8.5 |
| | 720 | 1.7 | 1.4 | | 1.0 |
| | 730 | 22.4 | 10.0 | 6.2 | 8.5 |
| | 750 | 1.7 | 2.8 | 2.1 | 2.5 |
| Spruce | 440-480 | 3.4 | 11.4 | 10.4 | 11.0 |
| Meadow and scree | 19,61 | 2.6 | | | |
| | 10 | 1.7 | | 6.2 | 2.6 |

[a]Habitat types and series are summarized in Appendix Table 32.

<u>Resting Locations.</u> Thirty-six of 48 radio locations identified by habitat type in the Big Hole were designated resting sites. These locations were noted at 26 individual

sites. Resting sites occurred in all habitat series (Table 9) and were used from 1 to 6 times (mean=1.3). Marten exhibited a preference for resting sites within the mesic subalpine fir series, an avoidance for xeric subalpine fir series sites and neither selection nor avoidance for all other series at the 90% selection level.

Table 9. Percent use by habitat series for 36 resting and 12 foraging marten radio telemetry locations from the Big Hole study area. (+) indicates selection and (-) indicates avoidance of the habitat type series based on 90% Bonferoni confidence intervals relative to 116 random points. Distribution of random points is given in Table 8.

| Habitat series | Resting locations | Foraging locations |
|---|---|---|
| Douglas-fir | 25.0 | 41.7 |
| Lodgepole pine | 8.3 | 8.3 |
| Mesic subalpine fir | +36.1 | 16.7 |
| Xeric subalpine fir | -11.1 | -16.7 |
| Spruce | 11.1 | 16.7 |
| Meadow and scree | 8.3 | |

A variety of resting site structures were selected by marten. Woody debris and logging slash provided the greatest number of resting sites. Large rocks in both forested and scree habitats were used frequently. One female was located under a boulder in a Douglas-fir habitat 6 times. Squirrel cone caches, hollow cavities in Douglas-fir trees, and debris attached to tree branches were used less frequently. Occasionally marten were observed sleeping on

branches of spruce or subalpine fir trees. Some resting sites were used into the spring and summer months.

<u>Foraging Locations.</u> Twelve of 48 radio locations were classified as foraging. Foraging locations occurred in every habitat series except meadow and scree (Table 9). The greatest number of foraging locations was in the Douglas-fir series; however, sample size was too low to reveal preference. The xeric subalpine fir series was used in less than expected proportions.

Marten were observed foraging at all times throughout the day. Foraging activities by marten were unpredictable in duration and distance travelled. Often marten activity appeared centered around a core area but sudden movements of up to 5 km out of core areas were common.

<u>Habitat Use Relative to Forestry.</u> No radio telemetry locations and only 2 marten tracks were noted within clear-cuts in the Big Hole study area. One track set crossed through several hundred meters of an approximately 200 ha, 20-year-old clear-cut while the other travelled approximately 100 m across the corner of a 1-year-old clear-cut unit less than 20 ha in size. Forest roads were crossed routinely by marten. Twenty-five of 141 random points fell within clear-cut boundaries. This proportion was significantly greater than the occurrence of marten locations within clear-cut boundaries ($\chi^2$=14.4, df=1,

P<0.001). Random points in clear-cuts were distributed in all habitat series except spruce.

West Yellowstone Flats

Marten used 4 of 5 habitat series and 8 of 11 habitat type groups in the West Yellowstone Flats. Habitat use determined from pooled radio and track locations (Table 10) did not conform to the same distribution as a comparable series of random points ($\chi^2$=21.5, df=3, P<0.001). I identified no use in the meadow and scree types. Combined 940 (Pinus contorta-Vaccinium scoparium) and 960 (Pinus contorta-unclassified understory) habitat types were preferred in radio and combined radio and track locations while 910 (Pinus contorta-Purshia tridentata) habitat was avoided in the radio location type only. Other locations types were used in proportions similar to their distribution within the random set.

Marten use of habitat burned by the 1988 North Fork fire on the eastern edge of the study area was minimal. Radiocollared marten crossed through extensive burned areas but were never located within the areas with either radio telemetry or snow tracking. In early June, marten 205 was located from a fixed wing aircraft in an unburned island of timber of approximately 0.5 ha. This island was approximately 1 km from contiguous, unburned habitat.

Table 10. Habitat series and habitat type distribution for random (n=116), track locations (n=22), radio locations (n=69), and all locations combined in the Flats study area. (+) indicates preference and (-) indicates avoidance of the habitat type for lodgepole pine and series for all others (90% Bonferoni confidence intervals.)

| Habitat series | Habitat type | Percent random | Percent tracks | Percent radio | Radio-track combined |
|---|---|---|---|---|---|
| Lodgepole pine | 910 | 66.4 | 72.7 | -42.0 | 49.5 |
| | 940 | 1.0 | 4.5 | +5.8 | +5.5 |
| | 960[a] | 4.3 | 18.2 | +36.2 | +31.9 |
| Douglas-fir | 310 | 1.0 | | 1.5 | 1.1 |
| | 320 | 4.3 | | 8.7 | 6.6 |
| Subalpine fir | 630 | 1.0 | | | |
| | 650 | 1.7 | 4.5 | | 1.1 |
| | 660 | 1.0 | | 1.5 | 1.1 |
| | 750 | | | 4.4 | 3.3 |
| Meadow and scree | 31-81 | 18.1 | -0.0 | -0.0 | -0.0 |
| | 10 | 1.7 | | | |

[a]Habitat 960 is undescribed by Pfister et. al (1977). It is characterized by a lodgepole pine overstory and bluejoint (Calamagrostis canadensis) understory.

Resting Locations. Twenty-eight individual resting sites were used a total of 53 times in the Flats study area. Sites were used from 1 to 11 times (mean=1.9) and represented 77% of all analyzed radio locations (n=69). Marten used combined 940 and 960 habitats more than expected (Table 11). Combined meadow and scree habitats, and 910 habitats were used less than expected. Douglas-fir and subalpine fir types were used in expected proportions.

Table 11. Percent use of habitat type by series for 53 resting and 16 foraging marten radio telemetry locations in the West Yellowstone Flats. (+) indicates selection and (-) indicates avoidance of the habitat series or habitat type group based on 90% Bonferoni confidence intervals. Distribution of random points is given in Table 10.

| Habitat series | Habitat type | Resting locations | Foraging locations |
|---|---|---|---|
| Lodgepole pine | 910 | -43.4 | 37.5 |
| | 940,960 | +35.8 | +62.5 |
| Douglas-fir | 310-320 | 13.2 | |
| Subalpine fir | 660-750 | 7.5 | |
| Meadow and scree | 31-81 10 | -0.0 | -0.0 |

Slash piles and areas of dense accumulation of woody debris were the most common marten resting sites, although a hollow lodgepole pine snag was used with the highest frequency (n=11). Some subnivean resting sites were not characterized by obvious structural attributes as marten appeared to burrow directly into the snow. As in the Big Hole, marten were occasionally observed sleeping on exposed branches or debris on tree limbs. Limb piles, consisting of smaller debris from commercial and private firewood cutting activities, were not used by marten despite being available in large numbers in a majority of the Flats area. No shift in resting site type was noted between winter and spring months.

Foraging Locations. Sixteen of 69 (23%) analyzed radio locations were classified as foraging. These locations were

restricted to the lodgepole pine habitat series, in which marten exhibited preference for the combined 940 and 960 habitats. The meadow and scree series was used in less than expected proportions.

One marten, a male, repeatedly crossed back and forth through several hundred meters of a sagebrush-grassland community that separated Horse Butte from the Flats area. This same marten crossed and recrossed ice-covered Hebgen Lake in the vicinity of Edwards peninsula in one 24-hour period.

Daytime foraging activity appeared to increase as snow cover decreased during the spring months. Ninety-one percent of locations for marten 845, the most intensively studied individual, were classified as resting during the winter months. This percentage dropped to 70% resting after March 15, 1990.

Habitat Use Relative to Forestry. Two tracks were noted within clear-cuts in the Flats area. One track occurred in the center of a 20-ha cutting unit that lacked regeneration. The second track occurred along the edge of a 15 to 20-year-old clear-cut with significant regeneration present. Forest roads were crossed routinely by marten. Highway 287 was crossed at least twice by 3 study animals. Eighteen of 134 random points fell within the boundaries of clear-cuts and were all classified as 910 habitats. This proportion was greater than the proportionate occurrence of

marten locations within clear-cut boundaries ($\chi^2$=5.3, df=1, P=0.02).

No radio locations were made within the boundaries of clear-cut units. However, marten repeatedly used large slash piles as resting sites within a power line right-of-way and within small (<1 ha) openings created by old (>20 years) timber cutting operations.

Beaver Creek

Fifteen radio and snow track locations were analyzed in Beaver Creek (Table 12). Track locations were distributed within the subalpine fir series while the radio locations were more evenly distributed throughout 3 representative series. The immediate loss of a majority of radiocollars to trapping, mortality, and unknown causes and difficult field conditions in this area precluded further habitat analysis of these data.

Table 12. Percent habitat use by habitat series and type in the Beaver Creek drainage for tracks (n=8) and radio locations (n=7).

| Habitat series | Habitat type | Track locations | Radio locations |
|---|---|---|---|
| Douglas-fir | 310 | | 14.3 |
| Spruce | 410 | | 14.3 |
| Subalpine fir | 630 | 25.0 | 14.3 |
| | 650 | | 42.9 |
| | 720 | | 14.3 |
| | 750 | 50.0 | |
| | 790 | 25.0 | |

## Physical Habitat Features

### Logging Slash and Ground Fuel

Big Hole. Mean combined logging slash and ground fuel (Table 13) ranged from 40.5 metric tons (mt)/ha for radio locations classified as resting in the xeric subalpine fir series to 155 mt/ha for radio locations for resting marten in the mesic subalpine fir series. Marten resting sites within the xeric subalpine fir series contained less slash or ground fuel than the random points with which they were compared ($t=5.7$, $P<0.001$) while track locations within the lodgepole pine series contained more slash or fuel ($t=2.7$, $P=0.02$).

Logging slash was noted in 27 of 118 (23%) analyzed marten locations. This proportion was not statistically different from the 14% logging slash occurrence in forested random locations ($\chi^2=2.1$, df=1, $P=0.14$). Two marten resting sites, each used twice, were formed exclusively from logging slash.

West Yellowstone Flats. Mean combined logging slash and ground fuel values (Table 14) varied from 11.4 mt/ha for resting locations in the subalpine fir series to 296.9 mt/ha for resting locations in the 910 habitat type of the lodgepole pine series. The mean for resting locations within the 910 habitat type was significantly greater than that for random points ($t=3.6$, $P=0.002$) and reflects the very high

dependence on slash piles and areas of blowdown with high levels of ground fuels. Two track locations within clear-cuts contained a mean of 1.7 mt/ha.

Sixty-nine percent of 91 marten locations had logging slash present while 37% of forested random locations (n=93) had logging slash present. This proportion was significantly greater than that of random points ($\chi^2$=18.6, df=1, P<0.001).

Table 13. Mean combined logging slash and ground fuel (metric tons/ha) by habitat series and location type from the Big Hole study area. Values in parentheses are standard deviations. Underlined values indicate significant differences from values at random points at the 0.05 error level.

| | Location classification | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Habitat | Random | | Resting | | Foraging | | Tracks | |
| series | n | $\bar{x}$ | n | $\bar{x}$ | n | $\bar{x}$ | n | $\bar{x}$ |
| Mesic subalpine fir | 13 | 137.8 (123) | 13 | 155.0 (85) | 2 | 79.4 (83) | 25 | 127.5 (145) |
| Xeric subalpine fir | 68 | 85.5 (53) | 4 | <u>40.5</u> (9) | | | 18 | 84.7 (50) |
| Lodgepole pine | 11 | 41.6 (32) | 3 | 113.2 (70) | | | 8 | <u>94.3</u> (49) |
| Spruce | 4 | 56.5 (75) | 4 | 127.4 (60) | | | 8 | 91.0 (71) |
| Douglas-fir | 15 | 48.2 (40) | 9 | 49.7 (95) | 5 | 76.5 (45) | 11 | 81.8 (43) |
| "Clear-cut" | 25 | 48.1 (55) | | | | | | |

Table 14. Mean combined logging slash and ground fuel (metric tons/ha) by habitat series and location type in the Flats study area. Values in parentheses are standard deviations. Underlined values indicate significant difference from random points at the 0.05 error level.

| Habitat series | Random n | Random $\bar{x}$ | Resting n | Resting $\bar{x}$ | Foraging n | Foraging $\bar{x}$ | Tracks n | Tracks $\bar{x}$ |
|---|---|---|---|---|---|---|---|---|
| Lodgepole pine 910 | 76 | 12.5 | 21 | <u>296.9</u> | 6 | 59.8 | 16 | 29.1 |
| | | (18) | | (358) | | (50) | | (57) |
| 940-960 | 7 | 23.5 | 19 | 26.2 | 10 | 49.9 | 5 | 45.3 |
| | | (20) | | (42) | | (47) | | (23) |
| Subalpine fir | 4 | 75.3 | 4 | 11.4 | | | 1 | 16.9 |
| | | (75) | | (19) | | | | |
| Douglas-fir | 6 | 127.1 | 7 | 143.5 | | | | |
| | | (142) | | (82) | | | | |
| Meadow and Scree | 23 | 5.9 | | | | | | |
| | | (18) | | | | | | |
| "Clear-cut" | 18 | 17.7 | | | | | 2 | 1.7 |
| | | (34) | | | | | | (2) |

<u>Canopy Cover</u>

<u>Big Hole.</u> Track locations within the Douglas-fir series in the Big Hole study area had significantly higher mean canopy cover (Table 15) than the set of random points with which it was contrasted ($t=2.5$, $P=0.02$). Other sets of marten locations did not differ from values at random points.

<u>West Yellowstone Flats.</u> Overall means for percent canopy cover (Table 16) were between 8 and 45% for sets of marten locations in the Flats. Mean values by habitat series for marten locations were not statistically different

from the sets of random locations used for comparison (t-tests, P>0.05).

Table 15. Mean percent canopy cover by habitat series and location type for the Big Hole study area. Values in parentheses are standard deviations. Underlined values indicate significant difference from values for random points at the 0.05 error level.

| Habitat series | Random n | Random $\bar{x}$ | Resting n | Resting $\bar{x}$ | Foraging n | Foraging $\bar{x}$ | Tracks n | Tracks $\bar{x}$ |
|---|---|---|---|---|---|---|---|---|
| | Location classification | | | | | | | |
| Mesic sub-alpine fir | 13 | 35 (16) | 13 | 40 (17) | 2 | 40 (28) | 25 | 37 (18) |
| Xeric sub-alpine fir | 68 | 16 (12) | 5 | 26 (17) | | | 18 | 23 (14) |
| Lodgepole pine | 11 | 14 (8) | 3 | 17 (20) | | | 8 | 24 (10) |
| Spruce | 4 | 21 (14) | 4 | 40 (16) | | | 8 | 44 (21) |
| Douglas-fir | 15 | 17 (6) | 9 | 19 (14) | 5 | 25 (14) | 11 | 27 (12) |

Table 16. Mean percent canopy cover by habitat series and location type for the Flats study area. Values in parentheses are standard deviations.

| Habitat series | Random n | Random $\bar{x}$ | Resting n | Resting $\bar{x}$ | Foraging n | Foraging $\bar{x}$ | Tracks n | Tracks $\bar{x}$ |
|---|---|---|---|---|---|---|---|---|
| | Location classification | | | | | | | |
| Lodgepole pine 910 | 76 | 8 (6) | 21 | 9 (9) | 6 | 11 (5) | 16 | 8 (6) |
| 940-960 | 7 | 15 (8) | 19 | 18 (12) | 10 | 23 (11) | 5 | 15 (9) |
| Subalpine fir | 4 | 12 (9) | 4 | 45 (29) | | | 1 | 10 |
| Douglas-fir | 6 | 37 (27) | 7 | 18 (23) | | | | |

## Basal Area

Big Hole. Radio locations for resting marten within the Douglas fir series had significantly greater basal area/hectare (t=2.3, P=0.03) and track locations less than (t=2.2, P=0.04) values for random points in the same series (Table 17). Radio locations classified as resting within the lodgepole pine series had significantly less basal area than random points (t=2.4, P=0.04). Mean basal area at radio locations of foraging marten within the mesic subalpine fir series were significantly less than values for the random points in the respective series (t=3.6, P=0.004).

Table 17. Mean basal area ($m^2$/ha) by habitat series and location type for the Big Hole study area. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level.

| Habitat series | Random n | Random $\bar{x}$ | Resting n | Resting $\bar{x}$ | Foraging n | Foraging $\bar{x}$ | Tracks n | Tracks $\bar{x}$ |
|---|---|---|---|---|---|---|---|---|
| Mesic subalpine fir | 13 | 35.6 (22) | 13 | 27.9 (18) | 2 | <u>13.5</u> (1) | 25 | 28.1 (17) |
| Xeric subalpine fir | 68 | 14.8 (9) | 4 | 18.8 (13) | | | 18 | 15.5 (7) |
| Lodgepole pine | 11 | 12.6 (4) | 3 | <u>9.3</u> (1) | | | 8 | 12.3 (9) |
| Spruce | 4 | 23.1 (12) | 5 | 51.2 (23) | | | 8 | 28.1 (15) |
| Douglas-fir | 15 | 34.8 (27) | 9 | <u>54.0</u> (14) | 5 | 18.4 (11) | 11 | <u>17.9</u> (11) |

West Yellowstone Flats. Mean basal area at marten locations varied between habitat series from 6.4 and 16.6 $m^2$/ha in the Flats study area (Table 18). Means for random points by habitat series were between 9.7 and 26.0 $m^2$/ha but were not statistically different from values at marten locations.

Table 18. Mean basal area ($m^2$/ha) by habitat series and location type in the Flats study area. Values in parentheses are standard deviations.

| Habitat series | Random n | Random $\bar{x}$ | Resting n | Resting $\bar{x}$ | Foraging n | Foraging $\bar{x}$ | Tracks n | Tracks $\bar{x}$ |
|---|---|---|---|---|---|---|---|---|
| Lodgepole pine 910 | 76 | 9.7 (8) | 21 | 6.4 (9) | 6 | 12.1 (8) | 16 | 7.9 (7) |
| 940-960 | 7 | 17.2 (7) | 19 | 13.6 (8) | 10 | 13.8 (6) | 5 | 11.3 (8) |
| Subalpine fir | 4 | 18.8 (9) | 4 | 16.2 (8) | | | 1 | 8.0 |
| Douglas-fir | 6 | 26.0 (15) | 7 | 16.6 (7) | | | | |

## Trees per Hectare

Big Hole. Marten resting sites in the Big Hole study area had significantly fewer mean trees per hectare than random points in the lodgepole pine ($t=4.8$, $P<0.001$) and the Douglas-fir ($t=2.5$, $P=0.02$) series. Other location types (Table 19) varied from 181 to 405 mean trees per hectare but were not statistically different from random points.

West Yellowstone Flats. Marten resting sites in the Flats study area had significantly fewer mean trees per hectare (Table 20) than random points in the 910 habitat type of the lodgepole pine series ($t=3.2$, $P=0.002$) and the subalpine fir series ($t=5.1$, $P=0.01$).

Table 19. Mean trees per hectare $\geq$ 12.7 cm dbh by habitat series and location type for the Big Hole study area. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level.

| Habitat series | Random n | Random $\bar{x}$ | Resting n | Resting $\bar{x}$ | Foraging n | Foraging $\bar{x}$ | Tracks n | Tracks $\bar{x}$ |
|---|---|---|---|---|---|---|---|---|
| Mesic subalpine fir | 13 | 406 (134) | 13 | 347 (148) | 2 | 181 (135) | 25 | 320 (174) |
| Xeric subalpine fir | 68 | 312 (171) | 4 | 200 (173) | | | 18 | 279 (129) |
| Lodgepole pine | 11 | 415 (113) | 3 | <u>252</u> (5) | | | 8 | 365 (150) |
| Spruce | 4 | 314 (206) | 5 | 405 (116) | | | 8 | 272 (208) |
| Douglas-fir | 15 | 334 (115) | 9 | <u>238</u> (73) | 5 | 380 (197) | 11 | 267 (101) |

## Stand Density Index

Big Hole. Marten locations classified as resting in the Douglas-fir series in the Big Hole study area had significantly higher mean stand density index (Table 21) than the random points in the same series ($t=2.4$, $P=0.03$). Random sets had significantly higher mean stand density index than track locations in the Douglas-fir series ($t=2.1$

P=0.04), resting locations in the lodgepole pine series (t=2.6, P=0.02), and foraging locations in the mesic subalpine fir series (t=3.6, P=0.003).

Table 20. Mean trees per hectare ≥ 12.7 cm dbh by habitat series and location type in the Flats study area. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 level.

| Habitat series | Random n | Random $\bar{x}$ | Resting n | Resting $\bar{x}$ | Foraging n | Foraging $\bar{x}$ | Tracks n | Tracks $\bar{x}$ |
|---|---|---|---|---|---|---|---|---|
| Lodgepole pine 910 | 76 | 253 (176) | 21 | <u>130</u> (145) | 6 | 226 (148) | 16 | 221 (190) |
| 940-960 | 7 | 337 (102) | 19 | 300 (218) | 10 | 347 (185) | 5 | 210 (120) |
| Subalpine fir | 4 | 369 (102) | 4 | <u>102</u> (23) | | | 1 | 411 |
| Douglas-fir | 6 | 186 (116) | 7 | 146 (142) | | | | |

Table 21. Mean stand density index by habitat series and location type for the Big Hole study area. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level.

| Habitat series | Random n | Random $\bar{x}$ | Resting n | Resting $\bar{x}$ | Foraging n | Foraging $\bar{x}$ | Tracks n | Tracks $\bar{x}$ |
|---|---|---|---|---|---|---|---|---|
| Mesic sub-alpine fir | 13 | 638 (371) | 13 | 490 (274) | 2 | <u>247</u> (42) | 25 | 490 (286) |
| Xeric sub-alpine fir | 66 | 300 (163) | 4 | 327 (234) | | | 18 | 291 (117) |
| Lodgepole pine | 11 | 268 (79) | 3 | <u>196</u> (24) | | | 8 | 263 (170) |
| Spruce | 4 | 408 (229) | 5 | 824 (311) | | | 7 | 540 (200) |
| Douglas-fir | 15 | 533 (330) | 9 | <u>790</u> (197) | 5 | 358 (197) | 11 | <u>322</u> (166) |

West Yellowstone Flats. Mean stand density index varied from 190 for track locations in the subalpine fir series to 322 in the combined 940 and 960 habitat types (Table 22) but were not statistically different from values from comparative random sets (t-tests, P>0.05).

Table 22. Mean stand density index by habitat series and location type for the Flats study area. Values in parentheses are standard deviations.

| Habitat series | Random n | Random $\bar{x}$ | Resting n | Resting $\bar{x}$ | Foraging n | Foraging $\bar{x}$ | Tracks n | Tracks $\bar{x}$ |
|---|---|---|---|---|---|---|---|---|
| Lodgepole pine 910 | 66 | 229 (135) | 11 | 235 (145) | 5 | 281 (107) | 12 | 218 (122) |
| 940-960 | 7 | 333 (132) | 18 | 322 (83) | 10 | 280 (123) | 5 | 214 (128) |
| Subalpine fir | 4 | 367 (151) | 4 | 247 (100) | | | 1 | 190 |
| Douglas-fir | 6 | 412 (234) | 7 | 274 (132) | | | | |

Snags per Hectare

Big Hole. Mean number of snags/ha at marten locations varied from 43 snags/ha for resting sites in the Douglas-fir series to 163 snags/ha for foraging sites in the mesic subalpine fir series (Table 23). Random sites varied between habitat series from 45 to 92 snags/ha. I did not find any significant differences between random and marten location values (t-tests, P>0.05).

<u>West Yellowstone Flats.</u> Resting locations in the Flats study area within the combined 940 and 960 habitat types of the lodgepole pine series and Douglas-fir series had significantly higher numbers of snags/ha (Table 24) than the random sets with which they were contrasted (940-960 t=3.2, P=0.004; Douglas-fir t=2.4, P=0.02). All other marten locations, by habitat series, did not differ from values in random sets (t-tests, P>0.05).

Table 23. Mean snags/ha $\geq$ 12.7 cm dbh by habitat series and location type in the Big Hole study area. Values in parentheses are standard deviations.

| | Location classification | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Habitat | Random | | Resting | | Foraging | | Tracks | |
| series | n | $\bar{x}$ | n | $\bar{x}$ | n | $\bar{x}$ | n | $\bar{x}$ |
| Mesic sub-alpine fir | 13 | 92 (21) | 13 | 112 (58) | 2 | 163 (53) | 25 | 95 (54) |
| Xeric sub-alpine fir | 68 | 80 (62) | 4 | 125 (91) | | | 18 | 69 (99) |
| Lodgepole pine | 11 | 45 (44) | 3 | 67 (58) | | | 8 | 96 (80) |
| Spruce | 4 | 69 (90) | 4 | 81 (24) | | | 8 | 97 (60) |
| Douglas-fir | 15 | 73 (62) | 9 | 43 (31) | 6 | 112 (44) | 11 | 64 (74) |

## U.S. Forest Service Summary Statistics

<u>Big Hole.</u> Marten utilized areas of higher mean board foot volume per acre (Table 25) than a comparable random group of uncut sites for pooled locations obtained through radio telemetry (Radio I t=2.3, P=0.03; Radio II t=2.4,

P=0.02) and track locations (t=3.7, P<0.001) in the Big Hole study area. Track locations were also characterized by higher mean cubic volume per hectare (t=3.4, P<0.001) and higher mean basal area (t=3.7, P=0.002). No differences in mean trees per hectare were detected between marten locations and random values (t-test, P>0.05). Values for two individual marten (Table 25) did not differ from random points in uncut areas.

Table 24. Mean snags/ha $\geq$ 12.7 cm dbh by habitat series and location type for the Flats study area. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level.

| | Location classification | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Habitat series | Random n | Random $\bar{x}$ | Resting n | Resting $\bar{x}$ | Foraging n | Foraging $\bar{x}$ | Tracks n | Tracks $\bar{x}$ |
| Lodgepole pine 910 | 76 | 95 (120) | 21 | 80 (47) | 6 | 65 (52) | 16 | 61 (89) |
| 940-960 | 7 | 100 (79) | 19 | <u>218</u> (74) | 10 | 158 (73) | 5 | 80 (130) |
| Subalpine fir | 4 | 94 (55) | 4 | 50 (30) | | | 1 | 125 |
| Douglas-fir | 6 | 29 (29) | 7 | <u>90</u> (38) | | | | |

<u>West Yellowstone Flats.</u> No differences were noted between mean summary values (Table 26) at marten locations and values at uncut random sites in the Flats study area (t-tests, P>0.05). Values varied widely, particularly within mean trees per hectare and mean volume. Low mean values in winter for marten 845 (Table 26) reflect the high dependence

on slash piles and blowdown.

Table 25. Mean trees per hectare (tr/ha) by diameter class, basal area, and volume produced with U.S. Forest Service stand examination software for groups in the Big Hole study area. Values from random points in clear-cuts were not contrasted statistically with other groups.

| Group | Sample size | tr/ha $\geq$12.7 cm dbh | tr/ha <12.7 cm dbh | Basal area ($m^2$/ha) | Volume $m^3$/ha | Volume bf/ac[a] |
|---|---|---|---|---|---|---|
| Random | | | | | | |
| Non Clear-Cut Random | 116 | 584 | 5125 | 25.6 | 168.9 | 8511 |
| Clear-cut | 25 | 23 | 4922 | 1.9 | 3.5 | 167 |
| Marten | | | | | | |
| Pooled Radio[b] I | 48 | 469 | 5884 | 27.5 | 200.1 | 12105[c] |
| Pooled Radio II | 37 | 495 | 5971 | 29.0 | 213.7 | 13083[c] |
| Tracks | 70 | 631 | 5486 | 34.0[c] | 239.1[c] | 14639[c] |
| Marten 970 | 16 | 537 | 6348 | 29.8 | 217.1 | 13268 |
| Marten 492 | 9 | 450 | 8896 | 24.7 | 191.7 | 12669 |

[a]Board feet/acre

[b]Represents all radio location sites used more than once as independent locations. Group II (n=37) represents all radio location sites only once regardless of the number of times the site was used.

[c]Indicates significant difference from forested random at the 0.05 error level.

Table 26. Mean trees per hectare (tr/ha) by diameter class, basal area, and volume produced with U.S. Forest Service stand examination software for groups in the Flats study area. Values from random points in clear-cuts were not contrasted statistically with other groups.

| Group | Sample size | tr/ha ≥12.7 cm dbh | tr/ha <12.7 cm dbh | Basal area ($m^2$/ha) | Volume $m^3$/ha | Volume bf/ac[a] |
|---|---|---|---|---|---|---|
| Random | | | | | | |
| Non Clear-Cut | 116 | 284 | 3317 | 11.8 | 60.6 | 2647 |
| Clear-cut | 19 | 31 | 2536 | 1.8 | 3.5 | 113 |
| Marten | | | | | | |
| Pooled Radio[b] I | 69 | 263 | 2707 | 12.1 | 60.3 | 2680 |
| Pooled Radio II | 41 | 337 | 3200 | 14.5 | 82.6 | 3700 |
| Tracks | 22 | 467 | 4751 | 16.9 | 81.2 | 2913 |
| Marten 845 | 27 Spring | 353 | 3459 | 16.2 | 93.0 | 4320 |
| Marten 845 | 9 Winter | 184 | 1565 | 8.3 | 44.3 | 1748 |
| Marten 205 | 6 | 421 | 3089 | 11.9 | 78.4 | 2967 |

[a]Board feet/acre

[b]Represents all radio location sites used more than once as independent locations. Group II represents all radio location sites only once regardless of the number of times the site was used.

## Ground Cover

Big Hole. Pooled marten locations in the Big Hole study area obtained with radio telemetry and treated as independent locations regardless of the number of times a site was used had a significantly higher frequency of

occurrence of rock cover in the >45% cover category ($\chi^2$=16.0, P<0.001) than a comparable forested random group (Table 27). Track locations had a significantly lower occurrence of thin duff cover in the 26-45% cover category ($\chi^2$=4.5, P=0.02). I did not detect any statistical differences between the distribution of marten locations and forested random locations among the classes in the cover variables log slash, natural accumulation, or bare soil (chi-squares, P>0.05).

Track locations in the Big Hole study area had a significantly higher occurrence of native grasses (Table 28) in the 1-25% cover category than forested random sites ($\chi^2$=7.9, df=1, P=0.005). The occurrence of menziesia (<u>Menziesia ferruginea</u>) in the 1-25% cover category was significantly greater than occurrence at random sites in both groups of pooled marten locations (Radio I $\chi^2$=16.7, df=1, P<0.001; Radio II $\chi^2$=13.5, df=1, P,0.001). This result is, however, obvious given the relative abundance of the subalpine fir-menziesia habitat type within pooled marten radio location groups and the relative scarcity in the forested random group. No differences in the percent occurrence of all forbs or pine grass (<u>Calamagrostis rubescens</u>) were detected between marten location groups and the forested random group (chi-squares, P>0.05).

Table 27. Frequency of ground cover for non-vegetative cover types, by location groups, in the Big Hole study area. Sample sizes are given in Table 25.

| Group | Percent cover range | Percent of observations: Rock | Log slash | Natural accumulation | Thin duff | Bare soil |
|---|---|---|---|---|---|---|
| Uncut Random | 1-25 | 23.3 | 7.8 | 70.7 | 38.0 | 10.3 |
| | 26-45 | 2.6 | | 19.0 | 30.2 | 4.3 |
| | >45 | 1.6 | | 1.6 | 14.6 | |
| Radio[b] I | 1-25 | 22.9 | 4.2 | 62.5 | 37.5 | 25.0 |
| | 26-45 | 2.1 | 10.4 | 25.0 | 14.6 | |
| | >45 | 23.0[a] | | 4.2 | 4.2 | |
| Radio II | 1-25 | 21.6 | 5.4 | 59.5 | 29.7 | 18.9 |
| | 26-45 | 2.7 | 8.1 | 27.0 | 18.9 | |
| | >45 | 10.8 | | 5.4 | 5.4 | |
| Tracks | 1-25 | 15.7 | 8.6 | 60.0 | 34.3 | 7.1 |
| | 26-45 | 1.4 | 5.7 | 25.7 | 12.9[a] | 1.4 |
| | >45 | 1.4 | 1.4 | 2.9 | 18.6 | |

[a]Indicates significant difference from random at the 0.05 error level.

[b]Represents all radio location sites used more than once as independent locations. Group II represents all radio location sites only once regardless of the number of times the site was used.

West Yellowstone Flats. Both pooling schemes for marten locations obtained with radio telemetry in the Flats study area were characterized by a higher occurrence of log slash and natural accumulation (Table 29) than forested random sites in the >45% cover category (Radio I $\chi^2$>12.6, df=1, P<0.001; Radio II $\chi^2$>5.0, df=1, P<0.02). Additionally, both of these groups and track locations had a higher occurrence of natural accumulation in the 26-45% cover category (Radio I $\chi^2$=6.1, df=1, P=0.01; Radio II $\chi^2$=13.6, df=1, P<0.001; Tracks $\chi^2$=5.4, df=1, P=0.02). Pooled marten

locations obtained with radio telemetry and treated as independent locations regardless of the number of times a site was used had a significantly lower frequency of occurrence of natural accumulation than forested random sites in the 1-25% cover category ($\chi^2$=6.6, df=1, P=0.01). This group also had a higher frequency of occurrence of thin duff cover in the 1-25% cover category than did forested random sites ($\chi^2$=6.4, df=1, P=0.01).

Table 28. Frequency of ground cover by vegetative cover type and location group in the Big Hole study area. Sample sizes are given in Table 25.

| Group | Percent cover range | Percent of observations | | | |
|---|---|---|---|---|---|
| | | Menziesia | All forbs | Pine grass | Native grasses |
| Uncut | 1-25 | 6.1 | 58.6 | 32.7 | 15.5 |
| Random | 26-45 | 3.4 | 6.0 | 2.6 | 0.8 |
| | >45 | | 1.6 | 2.6 | 1.7 |
| Radio[b] I | 1-25 | 33.3[a] | 70.8 | 41.7 | 25.0 |
| | 26-45 | | 2.1 | 4.2 | |
| Radio II | 1-25 | 32.4[a] | 67.6 | 45.9 | 29.7 |
| | 26-45 | | 2.7 | 5.4 | |
| Tracks | 1-25 | 7.1 | 64.3 | 35.7 | 35.7[a] |
| | 26-45 | | 8.6 | | 1.4 |
| | >45 | | 1.4 | 1.4 | 2.9 |

[a]Indicates significant difference from forested random at the 0.05 level.

[b]Represents all radio location sites used more than once as independent locations. Group II represents all radio location sites only once regardless of the number of times used.

Table 29. Frequency of ground cover for non-vegetative cover types, by location groups, in the West Yellowstone Flats study area. Sample sizes are given in Table 26.

| Group | Percent cover range | Percent of observations | | |
|---|---|---|---|---|
| | | Log slash | Natural accumulation | Thin duff |
| Uncut Random | 1-25 | 12.9 | 63.8 | 26.0 |
| | 26-45 | 1.7 | 6.1 | 17.3 |
| | >45 | | | 21.6 |
| Radio[b] I | 1-25 | 2.9 | 42.0[a] | 46.4[a] |
| | 26-45 | | 20.3[a] | 13.0 |
| | >45 | 21.7[a] | 14.5[a] | 11.5 |
| Radio II | 1-25 | 4.9 | 43.9 | 34.1 |
| | 26-45 | | 31.7[a] | 19.5 |
| | >45 | 9.8[a] | 12.2[a] | 17.1 |
| Track | 1-25 | 27.3 | 36.4 | 50.0 |
| | 26-45 | 9.1 | 27.3[a] | 9.1 |
| | >45 | | | 31.8 |

[a]Indicates significant difference from forested random at the 0.05 error level.

[b]Represents all radio locations sites used more than once as independent locations. Group II represents all radio location sites only once regardless of the number of times the site was used.

In the Flats study area 2 pooled marten locations groups obtained with radio telemetry had significantly lower percentages of locations in native grass cover in the 1-25% cover category (Table 30) than did comparable random sites (Radio I $\chi^2$=7.2, df=1, P=0.007; Radio II $\chi^2$=4.9, df=1, P=0.02). Marten locations obtained with radio telemetry and treated as independent sites regardless of the number of times the site was used had significantly fewer locations than random sites in the 1-25% cover category for

bitterbrush (Purshia tridentata) ($\chi^2$=8.6, df=1, P=0.003) and sedge (Carex spp.) ($\chi^2$=5.2, df=1, P=0.02) cover categories. Track locations did not differ from random values within any vegetative cover type (chi-squares, P>0.05). Forb cover at all marten locations was not different from the distribution of random values (chi-squares, P>0.05).

Table 30. Frequency of ground cover by vegetative cover type and location group in the West Yellowstone Flats study area. Sample sizes are given in Table 26.

| Group | Percent cover range | Percent of observations | | | |
|---|---|---|---|---|---|
| | | Bitter-brush | Native grasses | All forbs | Sedges |
| Uncut Random | 1-25 | 42.2 | 64.7 | 62.1 | 35.3 |
| | 26-45 | 2.6 | 14.7 | 17.3 | 0.8 |
| | >45 | 1.7 | 7.7 | 5.2 | 5.2 |
| Radio[b] I | 1-25 | 18.8[a] | 42.0[a] | 69.6 | 17.4[a] |
| | 26-45 | | 5.8 | 8.7 | |
| | >45 | 1.4 | 4.3 | 2.9 | |
| Radio II | 1-25 | 29.3 | 41.5[a] | 63.4 | 29.3 |
| | 26-45 | | 9.8 | 14.6 | |
| | >45 | 2.4 | 7.3 | 4.9 | |
| Tracks | 1-25 | 63.6 | 77.3 | 72.7 | 31.8 |
| | 26-45 | | 4.5 | 18.2 | |
| | >45 | | 9.1 | | |

[a]Indicates significant difference from forested random at the 0.05 error level.

[b]Represents all radio location sites used more than once as independent locations. Group II represents all radio locations sites only once regardless of the number of times used.

# DISCUSSION

## Harvest Dynamics

### Study Area Harvest

Marten have a reputation of being easy to trap (Soutiere 1979, Strickland et. al 1982). They have a keen sense of smell, move actively throughout their home ranges, and are extremely curious. Baited traps within their home ranges are not likely to escape their attention. My results support this reputation. Trappers succeeded in catching 27% (Beaver Creek) to 100% (Flats) of the marten I trapped in autumn prior to the fur-trapping season.

The consequences of the marten's vulnerability to trapping are less clear. Fur trapping did not eliminate marten from any of my study areas, nor did it decrease my live-trapping success in winter immediately following fur-trapping. I could not identify any influences of marten trapping on sex ratios.

The failure of fur trappers to influence my indices of population density could be due to any or all of 3 factors: 1) movements of new marten into trapped areas from untrapped refuges, 2) low intensity of fur trapping effort, or 3) ability of individual marten to avoid traps. Archibald and Jessup (1984) suggested marten populations in the Yukon

could be safely exploited at high levels provided: 1) marten trap lines were spaced far enough apart and, 2) permanent sanctuaries or untrapped refuges were maintained to provide surplus reproduction for trapped areas. I did not investigate the dispersal of marten from untrapped areas. However, I did find that trappers generally restricted trapping activity to specific portions of each study area, and each study area was bordered by either a wilderness area or a national park, which was untrapped. These untrapped areas could have served as refuges. Refuges are regarded as valuable management tools in Canada (de Vos 1951, Strickland et. al 1982).

The intensity of trapping varied among study areas, but the 1989-1990 trapping season was regarded as poor by trappers in all 3 study areas (Clemmans, Depas, and Whitman, Pers. Comm.). Trapping effort was exerted season-long only in the Big Hole study area, where trapping success was highest. The Beaver Creek and Flats areas were abandoned by trappers in early to mid January after it became evident that few marten were available to harvest.

Despite the marten's reputation for vulnerability, individuals possessed the ability to avoid traps. One female marten in the Big Hole study area successfully avoided 4 traps in her immediate activity center during the entire month of January. I believe marten that were live-trapped in January in the Flats study area, after trappers

abandoned their lines, succeeded in avoiding capture during the 4 weeks trappers were active primarily because of their large home ranges. These marten travelled extensively through very large home ranges in which only a small percentage of the total area contained traps.

The lack of information on the fates of 6 of 11 marked marten from the Beaver Creek study area complicated any conclusions on marten vulnerability to trapping in this area. These marten could have dispersed from the area, been poached, or simply avoided further capture. I personally regard poaching as the least likely scenario because of the territorial and watchful nature of the marten trapper in this area. Kujula (Pers. Comm.) may have identified 1 of the missing marten as a trap mortality in the 1990-1991 trapping season but evidence was not conclusive. This animal had torn ears that could have been an indication of lost eartags, but neither eartags nor radiocollar were recovered.

## Regional Harvest and Pelt Price

Marten harvest in southwest Montana during the 1989-90 trapping season was below the average from the preceding 10-year period but did not represent a low for the period. Pelt prices in 1989-90 were close to the average for the 1980-1990 period. Harvest per month of trapping season increased during the 1980-90 period as prices increased, indicating trappers responded quickly to favorable market

conditions. The strong positive relationship between pelt prices and total regional harvest that was present under a 4-month season disappeared under a 2-month season, suggesting that trappers did not, or could not, increase the monthly yield to make up for the decreased season length.

## Relative Population Density

Track transects indicated marten densities were highest in the Big Hole, intermediate in Beaver Creek, and lowest in the West Yellowstone Flats study area. These densities were consistent with historic patterns of marten harvest from these general areas. Winter live-trapping success suggested the same pattern, although live-trapping was not uniformly applied across all study areas. Autumn live-trapping did not support the same pattern.

Track transect densities from all study areas were below those reported from a low-density population in Ontario from 1982-1984 (Thompson and Colgan 1987). This fact, in conjunction with poor trapper success, may be sufficient to conclude that marten populations within the 3 study areas were low. The reasons for low population densities are unknown. Thompson and Colgan (1987) in Ontario and Weckworth and Hawley (1962) in Montana identified a shortage of primary prey as the major agent triggering declines in their study populations. High levels of fur trapping have also been identified as having profound

negative influences on marten populations (Koehler et. al 1975, Strickland et. al 1982, Thompson and Colgan 1987).

My seasonal live-trapping data did not support an over-harvest hypothesis in either the Big Hole or Beaver Creek study areas as success was similar between fall and winter in each area. In the Flats, my winter live-trapping success was similar to trapper success during the trapping season. Given that only 1 animal was harvested in this area during the 1989-1990 season, over-harvest was unlikely. Track transect results do not provide evidence either for or against an over-harvest hypothesis, as they were initiated after the opening of the trapping season. Track transect results only provide evidence of marten inhabiting trapped areas after the trapping season.

## Home Range

Marten home ranges varied widely among individuals and sexes but were generally much greater than home ranges of marten reported by Soutiere (1978) in Maine, Buskirk (1983) in Alaska, and Francis and Stephenson (1972) in Ontario. My home ranges were also greater than home ranges reported in 2 Montana studies. In Glacier Park, Montana, Burnett (1981) reported 70 to 120 ha home ranges for 4 male marten and a 60 ha home range for 1 female. Hawley and Newby (1957) reported similar home range sizes based on the live-trapping of grids in the same area.

Buskirk and McDonald (1989a) hypothesized that marten home range size was strongly related to site condition (habitat quality). This may explain part of the larger home range sizes of marten in the forest-grassland mosaic of the Flats area versus the more contiguous forests of the Big Hole study area. Soutiere (1979) noted increased home range size of marten living in areas with high levels of clear-cuts. Thompson and Colgan (1987) noted an increase in home range size in years with low prey density compared to years with high prey density. I did not make any attempt to quantify prey densities.

## Habitat Selection

Marten were found in all forested habitats in 2 study areas in southwest Montana. Non-forested habitats and a "clear-cut" habitat were used sparingly although scree types represented 8% of resting sites in the Big Hole and 1 marten in the Flats incorporated Horse Butte into his territory by regularly crossing at least several hundred meters of sagebrush-grassland. Marten did not typically loiter in non-forested habitats any longer than necessary, indicating they generally are creatures of forested environments.

Measures of habitat preference showed that marten occupied some forested habitats in proportions greater than their relative occurrence. Marten in the Flats study area were found more often that expected within 2 lodgepole pine

habitats which were restricted to riparian areas along Cougar Creek, Hebgen Lake, and the Madison River. Marten in the Big Hole study area were found more often than expected within mesic subalpine fir and Douglas-fir habitats.

This apparent selection for vegetation characteristics may involve selection for habitat type, selection for types that favor specific prey, or selection for physical characteristics associated with certain vegetation growth forms. I was unable to examine the 3 hypotheses independently. Mesic habitats, such as the preferred lodgepole pine types in the Flats and subalpine fir types in the Big Hole study area, have been identified as important habitats because they contain the marten's preferred prey (Koehler et. al 1975, Buskirk 1983). Buskirk et. al (1989b) found marten in Wyoming used old growth spruce and subalpine fir habitats more than expected because of a dependence on large woody debris for resting sites during winter. Douglas-fir habitat is usually not considered high quality marten habitat, but my data do not support the conclusion of Koehler et. al (1975) that Douglas-fir habitats "can be excluded from management consideration unless they are used as travel routes by martens enroute from one favored type to another."

## Physical Habitat Features

Marten in the Big Hole and Flats study areas occupied

sites that varied widely for the variables I analyzed. These variations were most pronounced between study areas, but I found little consistency between resting, foraging, and track sites analyzed within the same habitat series and study area. The lack of consistency could be due to small sample sizes or to a relatively wide tolerance for vegetation character by marten. Marten may be more adaptable to a variety of communities than the literature indicates. Clear-cuts and non-forested habitats are the exception as marten do not find areas without tree cover attractive.

Marten used woody debris for resting sites more frequently than any other type of resting structure. Buskirk et. al (1989b) noted a similar pattern in Wyoming. Marten sought out areas that were characterized by higher percent cover of debris in the Flats study area. In the Big Hole, woody debris was more evenly distributed and selection for high coverage of woody debris was not noted. Accumulation of woody debris is characteristic of old growth forests (Franklin et. al 1981), but logging may also produce this debris. The woody debris used for resting sites in the Flats study area had origins from natural processes and slash piles from logging and firewood cutting. In the Big Hole, a similar pattern was noted, but slash was less important as resting sites. Some slash piles in the Flats that consisted of limbs and other small debris did not

provide adequate structure for resting sites. I believe marten compete with firewood gatherers for areas of high accumulation of woody debris in the highly accessible Flats study area.

Standing dead trees (snags), another characteristic of old growth forests (Franklin et. al 1981), did not appear to be important prerequisites for marten use. Some habitats used by marten were characterized by high numbers of snags, and individual marten did profit from hollow cavities within snags, but patterns were not consistent. Overall, my data indicated that marten can survive in a variety of habitats with different structural attributes.

I believe that the Big Hole study area represented better habitat for marten than the Flats study area. The area was characterized by more contiguous forests and had a higher percentage of preferred habitats more evenly distributed throughout the study area. In order to find woody debris for resting, marten were not forced to travel extensively or show the high fidelity to resting sites that marten did in the Flats. This was because trees other than lodgepole pine inherently are of larger diameter and deadfall from larger trees is likely to provide more entrances to the subnivean environment where marten prefer to rest.

## CONCLUSIONS

The marten in southwest Montana is a forest dweller that requires forested habitats and is vulnerable to fur-trapping. Despite these limitations, the marten has persisted in its forested environment in the face of extensive trapping pressure and habitat alterations such as clear-cut logging and firewood cutting. Marten populations survived historically in areas where other valuable furbearers, such as the beaver, were eliminated by fur trapping.

I found populations to be low during the 1 year I was in the field. Fur-trapping evidently had little effect on marten populations in representative areas of southwest Montana during this year. Trappers limited their take under poor trapping conditions, and some marten were able to avoid capture when trappers were active in their home ranges. Large untrapped refuges adjacent to each area may have decreased the effects of marten harvest on local populations by providing surplus marten to replace trapped animals.

Marten were found in all forested habitats but showed preference for mesic habitats in my study areas. Mesic habitats used by marten would include not only old growth communities but also communities with few old growth

attributes. Marten used woody debris for resting sites, but they appear to be able to survive in areas in which intense logging and firewood cutting removed habitat structures based on fallen trees. Overall the marten is more resilient to human disturbance than the literature indicates.

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# APPENDIX

Table 31. Average marten pelt prices 1979-1989 and pelt price adjusted to 1979 values based on the Consumer Price Index (U.S. Department of Labor statistics).

| Year | Average price | % Inflation | Adjusted price |
|---|---|---|---|
| 1979 | 19.57 | | 19.57 |
| 1980 | 16.61 | 13.5 | 14.37 |
| 1981 | 14.13 | 10.3 | 10.90 |
| 1982 | 19.94 | 6.2 | 13.96 |
| 1983 | 29.83 | 3.2 | 19.93 |
| 1984 | 36.45 | 4.3 | 22.78 |
| 1985 | 19.27 | 3.6 | 11.35 |
| 1986 | 24.50 | 1.9 | 13.96 |
| 1987 | 30.00 | 3.6 | 16.02 |
| 1988 | 39.40 | 4.1 | 19.42 |
| 10-year average | 24.97 | 5.6 | 16.23 |
| 1989 | 28.38 | 4.8 | 12.63 |

Table 32. Non-forested habitat types (Mueggler and Stewart 1980) and forested habitat types (Pfister et. al 1977) by code, scientific, and common name.

| Habitat code by series | Scientific name | Common name |
|---|---|---|
| Meadow and scree series | | |
| 010 | | Scree |
| 017 | Agropyron spicatum | Bluebunch wheatgrass |
| 019 | Festuca scabrella | Rough fescue |
| 032 | Artemesia tridentata | Big sagebrush |
| 061 | Carex spp. | Sedges |
| 074 | Salix spp. | Willows |
| 078 | Populus tremuloides | Quaking aspen |
| Douglas-fir series | Psuedotsuga mesziesii- | Douglas-fir |
| 310 | Symphoricarpus albus | Snowberry |
| 320 | Calamagrostis rubescens | Pinegrass |
| 330 | Carex geyeri | Elk sedge |
| Picea series | Picea spp.- | Spruce |
| 410 | Equisetum arvense | Common horsetail |
| 440 | Galium triflorum | Sweetscented bedstraw |
| 470 | Linnaea borealis | Twinflower |
| 480 | Smilacina stellata | Starry Solomon's seal |
| Mesic[a] sub-alpine fir series | Abies lasiocarpa- | Subalpine fir |
| 630 | Galium triflorum | Sweetscented bedstraw |
| 650 | Calamagrostis canadensis | Bluejoint |
| 670 | Menziesia ferruginea | Menziesia |

Table 32. (Continued)

| Habitat code by series | Scientific name | Common name |
|---|---|---|
| Xeric[a] subalpine fir series | Abies lasiocarpa- | Subalpine fir |
| 690 | Xerophyllum tenax | Beargrass |
| 720 | Vaccinium globulare | Blue huckleberry |
| 730 | Vaccinium scoparium | Grouse whortleberry |
| 750 | Calamagrostis rubescens | Pinegrass |
| Lodgepole pine series | Pinus contorta- | Lodgepole pine |
| 910 | Purshia tridentata | Bitterbrush |
| 940[b] | Vaccinium scoparium | Grouse whortleberry |
| 950 | Calamagrostis rubescens | Pinegrass |
| 960[c] | Unclassified | |

[a]The mesic and xeric subalpine fir series are combined into a lower subalpine type in Pfister et. al (1977). Warren (1989) divides these types by soil moisture as shown here.

[b]940 and 950 are designated community types in Pfister et. al (1977) but are used as habitat types within the U.S. Forest Service Timber Management Data Handbook (1985) and in text throughout this document.

[c]The 960 habitat code is my designation and the type is not classified in Pfister et. al (1977). The type was characterized by a lodgepole overstory and predominately bluejoint (Calamagrostis canadensis) understory.